Sediment Dispersal in the Gulf of Lions:
Water Column Dynamics and Potential for Cross-Margin Transport

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LONG-TERM GOALS

The most general long-term goals of this study, as part of EuroSTRATAFORM, are to investigate the oceanic processes that erode, transport,and deposit sediment in the margin system, and how fine sediment erosion, transport and accumulation impact water-column turbidity and seabed strata where modern fluvial sediment is transferred across a continental shelf.

OBJECTIVES

This project is a continuation of the EuroSTRATAFORM project and the objectives over the past year focused on new field work in the Gulf of Lions beginning in October 2004. The specific objective for the Gulf of Lions is to investigate the interaction of water column dynamics with trapping and transport of suspended sediment.

A new objective developed late in the year. The new objective is to examine optical response to sediment resuspension events using an Autonomous Profiler in collaboration with the OASIS project taking place at the Marthas Vineyard Coastal Observatory.

APPROACH

Gulf of Lions: This project focused on documenting the influence of the water column response to changing wind conditions as a means to trap sediments close to the river mouth and then potentially transport them across the shelf. The goal was to continuously document the vertical distribution of water column properties (salinity, temperature, and therefore density) and suspended sediment, in conjunction with time-series measurements of the flow.

The area of interest is the western region of the Gulf of Lions, France. The observation that modern sediment is being transported down the numerous canyons that incise the shelf prompted the inestigation of cold water formation as a possible mechanism for cross –shelf transport of fine sediments. While cold water flows have been observed in the canyons, and are known to have a distinctive turbid signal as well as low temperature, the initiation of these events, presumably on the shelf, has not been documented.

The principle tool is an Autonomous Profiler (AP). An instrument package, equipped with a CTD and Optical Backscatterance Sensor (OBS), is attached to a programmable, submersible winch. The

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14. ABSTRACT
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buoyant instrument package when reeled in sits on the bottom, and is released to the surface at a pre-programmed time interval, and then reeled back down to the bottom, recording CTD/OBS. Combined with an upward looking ADCP, quasi-continuous high resolution (vertically) water column properties, suspended sediment, and velocity are obtained throughout the entire water column. In the case of the Gulf of Lions, where changes from well-mixed to stratified (upwelling) conditions may determine the likely pathway for sediment dispersal (i.e. coastal current or episodic gravity flows), quasi-continuous records of the entire water column would be useful for assessing the importance of these different pathways.

WORK COMPLETED

Gulf of Lions: Three research cruises were completed between October 2004 and April 2005. Permission to deploy instrumentation in French waters was not granted in time for an October deployment of the AP, thus the fall/winter transition from stratified to mixed conditions was not captured. The AP was deployed in February at 27 m depth off the Tet River. Profiler worked as programmed for 24 hours and then apparently shorted out and remained at the surface for a several days. The instrument was recovered but was unable to be repaired and redeployed in the time remaining on the cruise.

Numerous hydrographic and ADCP surveys were completed on each of the three cruises with a combination of instruments – the ship's rosette/CTD system for deep water casts, a Seabird CTD and Ocean Sensors CTD with a single Niskin bottle for shallow water and near bottom suspended sediment samples. Suspended sediment was determined from filtered water samples obtained from each cast.

Upon return to Woods Hole, the AP was repaired and tested at the Marthas Vineyard Coastal Observatory for a two-week deployment in August 2004. The AP was deployed again from September 3 to September 12 2005 in conjunction with the OASIS project which is examining the optical and acoustic response to sediment resuspension events.

RESULTS

Gulf of Lions: Due to the disappointing data return from the Gulf of Lions experiment, most of the effort since return from the field focused on repair and redeployment of the AP. However, collaboration is in progress with Xavier Durrieu de Madron and Jerome Bonin (Universite de Perpignon) to calibrate the independent optical sensors used on hydgrographic surveys (transmissometer on the ship's rosette, Optical Backscatterance Sensors (OBS) on other profilers, and an internally recording OBS is on loan to the Universite de Perpignan to continue a longer time series at the Tet buoy.

Some preliminary results from the AP OASIS deployment (only two weeks old at the time of writing this report) are presented in Fig. 1. The top panel shows temperature which determines the density (salinity was nearly vertically homogenous). The bottom panel shows the OBS output in counts for the lower 5 m of the water column with wave height superimeposed. Backscatterance near the bed increased on September 7 and 9, coinciding with increase in wave height. There were other periods of increased backscatterance from September 10 to 12 which do not coincide with an increase in wave height. September 10 to 12 does experience cooler water temperatures which could indicate the sediment suspension signals during this time are advective. The issue of resuspension versus advection

is often one of the critical questions for suspended sediment time series observations. These data will be useful in combination with observations of particle characteristics and detailed flow measurements carried out by other investigators (Boss, Hill, Milligan, Trowbridge).

IMPACT/APPLICATIONS

The development of the Autonomous Profiler for deployment on the shelf is a technological advance with great potential for future work. It is analogous to the advance of single point velocity measurements from rotor or electromagnetic current meters to continuous water column profiles of velocity from an acoustic doppler current profiler. Combination of surface to bottom temperature, salinity, and backscatterance measurements provides greater perspective for detailed boundary layer time series, and potential spatial gaps that occur with CTDs mounted on moorings.

TRANSITIONS

See Related Projects below.

RELATED PROJECTS

Collaboration continues with Geyer (WHOI), and Sherwood (USGS) to complete model comparisons with large scale spatial observations from the hydrographic surveys and time-series measurements from the Apennine margin (PASTA). Similarly, nearshore time-series measurements at the Tet River site (Kineke, Wheatcroft) will be integrated with studies of particle dynamics (Hill, Milligan), cross-shelf hydrographic measurements (Kineke, Durrieu de Madron). Data collected with the Autonomous Profiler will be integrated with observations by other researchers involved with OASIS, particularly Boss (U Maine), Hill (Dalhousie), Milligan (Bedford Institute of Oceanography), and Trowbridge (WHOI).

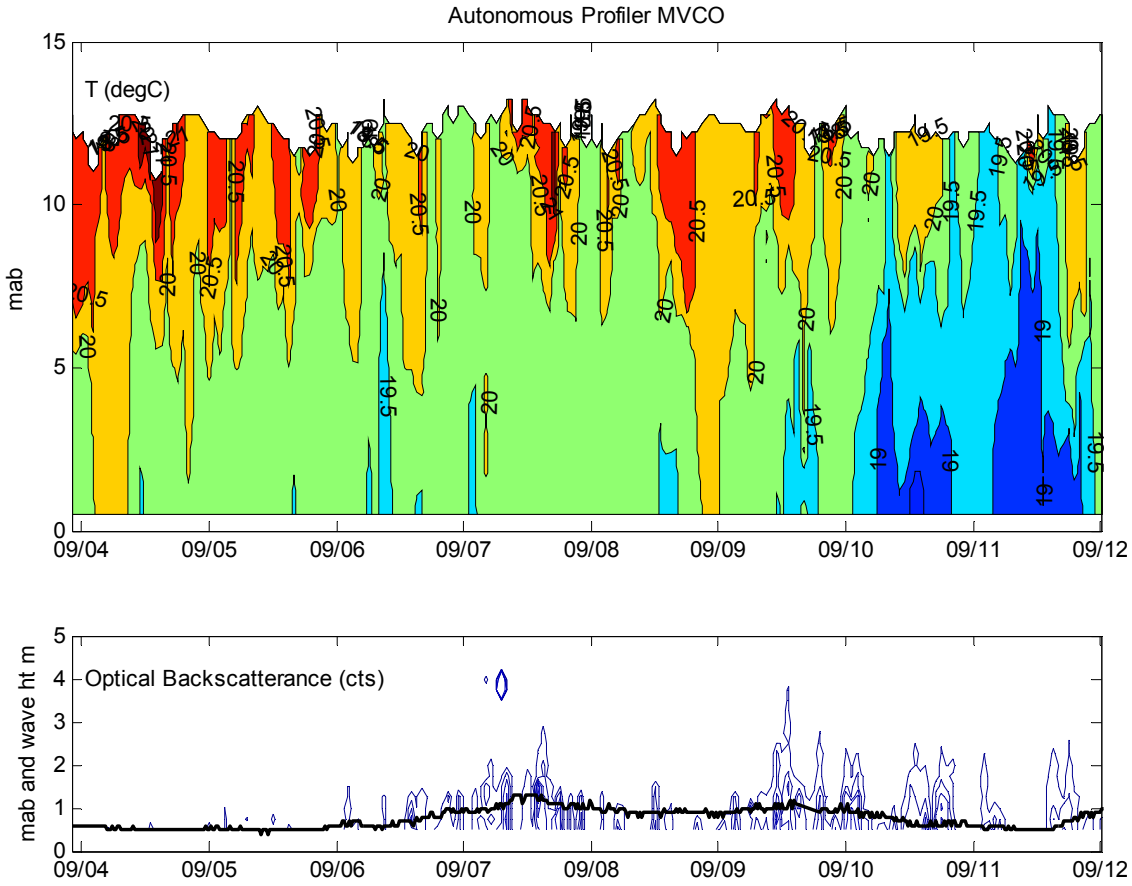

Figure 2. Preliminary data from the Autonomous Profiler deployment at Marthas Vineyard Coastal Observatory (MVCO), September 2005. Data were obtained from hourly casts. The top panel presents temperature, which dominates the density signal, and shows a cooling of bottom waters at the end of the deployment. The bottom panel shows the Optical Backscatterance signal in the lower five m of the water column. Superimposed on the OBS signal is the wave height obtained from the MVCO web site (http://www.whoi.edu/mvco; Woods Hole Oceanographic Institution 9/30/2005). The suspended sediment is correlated with wave height for September 7 and 9, but events on September 10 through 12 are not and may be advected with the cooler water mass.